NASA/TM—2000–209891, Vol. 213

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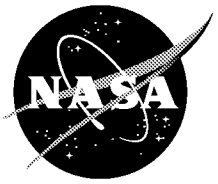

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Sara Conrad, Editors

Volume 213

BOREAS TF-11 Decomposition Data over the SSA-Fen

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National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

November 2000

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Hanover, MD 21076-1320
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BOREAS TF-11 Decomposition Data over the SSA-Fen

David Valentine

Summary

The BOREAS TF-11 team collected several data sets in its efforts to fully describe the flux and site characteristics at the SSA-Fen site. This data set contains decomposition rates of a standard substrate (wheat straw) across treatments. The measurements were conducted in 1994 as part of a 2 x 2 factorial experiment in which we added carbon (300 g/m^2 as wheat straw) and nitrogen (6 g/m^2 as urea) to four replicate locations in the vicinity of the TF-11 tower. The data are stored in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TF-11 Decomposition Data over the SSA-Fen

1.2 Data Set Introduction

This data set contains decomposition rates of a standard substrate (wheat straw) across treatments. The measurements were conducted as part of a 2 x 2 factorial experiment in which we added carbon (300 g/m^2 as wheat straw) and nitrogen (6 g/m^2 as urea) to four replicate locations in the vicinity of the Tower Flux (TF)-11 tower.

1.3 Objective/Purpose

Much of the area within the boreal forest biome consists of wetlands, in which large carbon stores and high water tables drive fundamentally different atmospheric interactions than occur under the other forest types studied by the BOReal Ecosystem-Atmosphere Study (BOREAS). One key difference is in the form carbon is emitted following soil microbial respiration; in wetlands, much of it is emitted as methane. Wetlands are the dominant influence of boreal forests on atmospheric methane.

This study was undertaken in order to assess responses of methane emissions in northern wetlands to potential changes in plant productivity, nitrogen availability or both. Whiting and Chanton (1993) recently observed that methane emissions from wetlands across the globe are well related to net primary productivity (NPP). This may be for a variety of reasons, including enhanced plant transport, increased methanogenic substrates from root exudates, increased litter input cascading to enhanced substrate availability for methanogenesis, or enhanced C and N mineralization of decomposing residues. Previous work by us (Valentine et al., 1994) and others has shown that substrate availability is a key constraint on methane production in wetlands. The present study was an effort to test whether substrate manipulation results from laboratory studies could be mirrored under field conditions.

1.4 Summary of Parameters

We report the mass loss of a standard plant material (wheat straw) over the course of ~50 days as a function of treatment and location. We also report the initial and final concentrations of carbon and nitrogen (mass basis).

1.5 Discussion

These data were collected from a set of small locations within the fen, and therefore no one location represented the entire study site. In fact, the fen in which this work was conducted was characterized by a large-scale gradient of vegetation, microtopography, and hydrology such that the study site itself is representative only of the portion of the fen in which it was located (i.e., the lower 1/3).

1.6 Related Data Sets

BOREAS TE-06 Biomass Estimate Data
BOREAS TE-18 Biomass Density Image of the SSA
BOREAS TGB-03 Plant Species Composition Data over the NSA-Fen

2. Investigator(s)

2.1 Investigator(s) Name and Title

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2.2 Title of Investigation

Influence of Substrate Characteristics and Other Environmental Factors on Methane Emissions from the BOREAS Southern Study Area Fen Site. III. Standard Litter Decomposition

2.3 Contact Information

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3. Theory of Measurements

Litter bags were constructed from fiberglass screen to hold ~3 g of plant material. Once filled with wheat straw and weighed, they were placed within each of the treatment/location replicates and allowed to remain for ~50 days. They were then collected and reweighed, and the fraction of the original weight remaining is reported in the accompanying file.

4. Equipment

4.1 Sensor/Instrument Description

Not applicable.

4.1.1 Collection Environment

The litter bags were set out around the end of July (21-Jul or 02-Aug-1994), then retrieved on 17-Sep-1994. Half the bags were placed on the surface of the peat, and half were inserted 0.1 m below the surface.

4.1.2 Source/Platform

Not applicable.

4.1.3 Source/Platform Mission Objectives

Recent papers (e.g., Whiting and Chanton, 1993) have suggested that CH_4 emissions are positively related to plant productivity. One possible mechanism by which enhanced NPP or other factors may result in higher CH_4 emissions is through enhanced decomposition rates, perhaps indexing a more rapid substrate supply rate from fermentative processes. We therefore wanted to evaluate whether enhanced litter decomposition rates (i.e., mass loss) covaried with CH_4 emissions rates or varied as a function of our C and N additions.

4.1.4 Key Variables

Name	Unit	Description
FRAC	Not applicable	Fraction of wheat straw mass remaining
C	Not applicable	C fraction of wheat straw
H	Not applicable	H fraction of wheat straw
N	Not applicable	N fraction of wheat straw

4.1.5 Principles of Operation
Not applicable.

4.1.6 Sensor/Instrument Measurement Geometry
Not applicable.

4.1.7 Manufacturer of Sensor/Instrument
Not applicable.

4.2 Calibration

4.2.1 Specifications
Not applicable.

4.2.1.1 Tolerance
Not applicable.

4.2.2 Frequency of Calibration
Not applicable.

4.2.3 Other Calibration Information
Not applicable.

5. Data Acquisition Methods

Approximately 3 g of wheat straw was sealed into each fiberglass mesh screen. Oven dry equivalent weights for each were determined based on additional subsamples. Two replicate bags for each treatment/platform combination were either laid on the surface or inserted 0.1 m into the peat near the end of July, then collected in mid-September. Each bag was oven-dried at 30 °C for 48 h, then weighed. Subsamples were ground and analyzed using a Leco CHN analyzer for C, H, and N concentrations.

Subsamples from the initial (undecomposed) wheat straw were similarly analyzed for C, H, and N concentrations:

```
C_ADDED,N_ADDED,DURATION,REPLICATE_ID,LITTER_MASS_FRACTION,C_CONC,H_CONC,N_CONC
Initial,0,0,0,0,0,1,.446,.061,.005
```

6. Observations

6.1 Data Notes
Vegetative growth lifted some of the bags off the peat surface during the decomposition period, and the resultant drying likely retarded those.

6.2 Field Notes
None.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

All measurements were made along two transects identified by their location relative to the TF-11 micrometeorology tower: a north transect (NA and NB platforms) and a south transect (SA and SB platforms). All measurements were made within 70 m of the TF-11 tower, whose North American Datum of 1983 (NAD83) coordinates are 53.80206°N, 104.61798°W.

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

The data are from point measurements at the given locations.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

Litter bags were placed either on 21-Jul-1994 (north transect) or 02-Aug-1994 (south transect). All bags were collected on 17-Sep-1994.

7.2.2 Temporal Coverage Map

None.

7.2.3 Temporal Resolution

Ideally, the litter bags would have been placed at the beginning of the growing season. Because of a miscommunication from the Principal Investigator (PI) to the field crew, the bags were not placed until much later than optimal.

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

```
         Column Name
------------------------------
SITE_NAME
SUB_SITE
START_OBS_DATE
END_OBS_DATE
PEAT_DEPTH
C_ADDED
N_ADDED
DURATION
REPLICATE_ID
LITTER_MASS_FRACTION
C_CONC
H_CONC
```

N_CONC
SITE_COMMENTS
CRTFCN_CODE
REVISION_DATE

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
START_OBS_DATE	The date and time at which collection of the referenced data commenced.
END_OBS_DATE	The date and time at which collection of the referenced data was terminated.
PEAT_DEPTH	The depth below the peat surface.
C_ADDED	Estimated amount of carbon contained in the wheat straw that was added to the plot.
N_ADDED	Estimated amount of nitrogen contained in the urea that was added to the plot.
DURATION	Duration of time that the samples were in the field since 21-JUL-94 or 02-AUG-94.
REPLICATE_ID	Replicate id, where 2 denotes a replicate.
LITTER_MASS_FRACTION	Fraction of original litter mass remaining.
C_CONC	Carbon concentration of remaining littermass
H_CONC	Hydrogen concentration of remaining littermass
N_CONC	Nitrogen concentration of remaining littermass
SITE_COMMENTS	Descriptive information to clarify or enhance the site information.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
START_OBS_DATE	[none]
END_OBS_DATE	[none]
PEAT_DEPTH	[millimeters]
C_ADDED	[grams C][meter^-2]
N_ADDED	[grams C][meter^-2]
DURATION	[days]
REPLICATE_ID	[unitless]
LITTER_MASS_FRACTION	[unitless]
C_CONC	[grams C][grams litter^-1]
H_CONC	[grams H][grams litter^-1]
N_CONC	[grams N][grams litter^-1]
SITE_COMMENTS	[none]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS Staff]
SUB_SITE	[Assigned by BORIS Staff]
START_OBS_DATE	[Investigator]
END_OBS_DATE	[Investigator]
PEAT_DEPTH	[Investigator]
C_ADDED	[Investigator]
N_ADDED	[Investigator]
DURATION	[Investigator]
REPLICATE_ID	[Investigator]
LITTER_MASS_FRACTION	[Balance]
C_CONC	[Leco CHN analyzer]
H_CONC	[Leco CHN analyzer]
N_CONC	[Leco CHN analyzer]
SITE_COMMENTS	[Investigator]
CRTFCN_CODE	[Assigned by BORIS Staff]
REVISION_DATE	[Assigned by BORIS Staff]

7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-FEN-FLXTR	SSA-FEN-FLXTR	None	None	None	None
SUB_SITE	9TF11-DEC01	9TF11-DEC07	None	None	None	None
START_OBS_DATE	21-JUL-94	02-AUG-94	None	None	None	None
END_OBS_DATE	17-SEP-94	17-SEP-94	None	None	None	None

```
PEAT_DEPTH           0              100            None    None   None    None
C_ADDED              0              300            None    None   None    None
N_ADDED              0              6              None    None   None    None
DURATION             46             58             None    None   None    None
REPLICATE_ID         1              2              None    None   None    None
LITTER_MASS_FRACTION .64            1.14           None    None   None    None
C_CONC               .361           .469           None    None   None    None
H_CONC               .05            .063           None    None   None    None
N_CONC               .002           .008           None    None   None    None
SITE_COMMENTS        N/A            N/A            None    None   None    None
CRTFCN_CODE          CPI            CPI            None    None   None    None
REVISION_DATE        01-OCT-98      01-OCT-98      None    None   None    None
--------------------------------------------------------------------------------
Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value  -- The value that indicates missing data. This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the attempt was unsuccessful.
Unrel Data Value   -- The value that indicates unreliable data.  This is used
                      to indicate an attempt was made to determine the
                      parameter value, but the value was deemed to be
                      unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the
                      instruments detection limits.  This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the analysis personnel determined
                      that the parameter value was below the detection
                      limit of the instrumentation.
Data Not Cllctd    -- This value indicates that no attempt was made to
                      determine the parameter value.  This usually
                      indicates that BORIS combined several similar but
                      not identical data sets into the same data base table
                      but this particular science team did not
                      measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.
N/A   -- Indicates that the value is not applicable to the respective column.
None  -- Indicates that no values of that sort were found in the column.
--------------------------------------------------------------------------------
```

7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,START_OBS_DATE,END_OBS_DATE,PEAT_DEPTH,C_ADDED,N_ADDED,
DURATION,REPLICATE_ID,LITTER_MASS_FRACTION,C_CONC,H_CONC,N_CONC,SITE_COMMENTS,
CRTFCN_CODE,REVISION_DATE
'SSA-FEN-FLXTR','9TF11-DEC01',21-JUL-94,17-SEP-94,0,300,6,58,1,.87,.446,.061,
.002,'North of Tower, along transect A','CPI',01-OCT-98
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) is the measurement(s) made for a given site on a given day.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

Not applicable.

9.1.1 Derivation Techniques and Algorithms

None.

9.2 Data Processing Sequence

9.2.1 Processing Steps

None.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None.

9.3.2 Calculated Variables

Not applicable.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

The most obvious source of error was the tendency for the litter bags to be lifted above the peat surface by vegetative growth, potentially retarding decomposition through excessive drying. Other sources of error include solubilization of straw constituents resulting in overstatement of decomposition rate, exclusion of soil fauna by the bag screen itself, and moss or other growth in the bag causing a mass gain during the period.

10.2 Quality Assessment

10.2.1 Data Validation by Source
Not applicable.

10.2.2 Confidence Level/Accuracy Judgment
Except for the bags that gained weight during the decomposition period, these data appear fairly robust. The aforementioned gainers should be deleted prior to analysis.

10.2.3 Measurement Error for Parameters
Not applicable.

10.2.4 Additional Quality Assessments
None given.

10.2.5 Data Verification by Data Center
Data were examined for general consistency and clarity.

11. Notes

11.1 Limitations of the Data
See Sections 9.1 and 10.1.

11.2 Known Problems with the Data
None given.

11.3 Usage Guidance
See Sections 9.1 and 10.1.

11.4 Other Relevant Information
None given.

12. Application of the Data Set

Several avenues are being pursued in publications now being produced to answer the following questions:

- How do CH_4 flux measurements compare by technique used in measurement?
- How and why do CH_4 flux measurements vary through time and across the landscape?
- Does plant productivity limit CH_4 emissions?

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description
We used only commercially available software, mostly the Quattro Pro spreadsheet.

14.2 Software Access
Not applicable.

15. Data Access

The decomposition data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

None.

17.2 Journal Articles and Study Reports

Klinger, L.F., P.R. Zimmerman, J.P. Greenberg, L.E. Heidt, and A.B. Guenther. 1994. Carbon trace gas fluxes along a successional gradient in the Hudson Bay lowland. Journal of Geophysical Research 99:1469-1494.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).
Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102(D24): 28,731-28,770.

Valentine, D.W., E.A. Holland, and D.S. Schimel. 1994. Ecosystem and physiological controls over methane production in northern wetlands. Journal of Geophysical Research 99(D1):1563-71.

Whiting G.J. and J.P. Chanton. 1993. Primary production control of methane emission from wetlands. Nature 364:794-5.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

ASCII - American Standard Code for Information Interchange
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS - BOREAS Information System
CD-ROM - Compact Disk-Read-Only Memory
DAAC - Distributed Active Archive Center
EOS - Earth Observing System
EOSDIS - EOS Data and Information System
GIS - Geographic Information System
GSFC - Goddard Space Flight Center
HTML - HyperText Markup Language
NAD83 - North American Datum of 1983
NASA - National Aeronautics and Space Administration
NPP - Net Primary Productivity
NSA - Northern Study Area
ORNL - Oak Ridge National Laboratory
PANP - Prince Albert National Park
PBR - Productivity/Biomass Ratio
PI - Principal Investigator
SSA - Southern Study Area
TE - Terrestrial Ecology
TF - Tower Flux
TGB - Trace Gas Biogeochemistry
URL - Uniform Resource Locator

20. Document Information

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20.4 Citation

When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:

Valentine, D.W. 1996. Influence of substrate characteristics and other environmental factors on methane emissions from the BOREAS Southern Study Area fen site. III. Standard litter decomposition.

If using data from the BOREAS CD-ROM series, also reference the data as:

Valentine, D., "Influence of Substrate Characteristics and Other Environmental Factors on Methane Emissions from the BOREAS Southern Study Area Fen Site. III. Standard Litter Decomposition." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

20.5 Document Curator

20.6 Document URL

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The BOREAS TF-11 team collected several data sets in its efforts to fully describe the flux and site characteristics at the SSA-Fen site. This data set contains decomposition rates of a standard substrate (wheat straw) across treatments. The measurements were conducted in 1994 as part of a 2 x 2 factorial experiment in which we added carbon (300 g/m^2 as wheat straw) and nitrogen (6 g/m^2 as urea) to four replicate locations in the vicinity of the TF-11 tower. The data are stored in tabular ASCII files.

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